NASA-TM-110714

7N-31-TM

60167

P-13

NASA

AMES RESEARCH CENTER

SYSTEM ENGINEERING REPORT

Report No. NK-004
Date 9/90
Prep. by Kunz
Page 1 of 12
Alternate #

SUBJECT

CAVITY DOOR DESIGN FOR SOFIA

PROJECT SOFIA

DISTRIBUTION

(NASA-TM-110714) CAVITY DOOR DESIGN FOR SOFIA (NASA. Ames Research Center) 13 p

N95-71481

Unclas

Z9/31 0060167

NASA

Ames Research Center

System Engineering Report

Report No. [illegible]-004

Date 9-12-90

Prep. by [illegible]

Page of

SUBJECT Cavity [illegible]

PROJECT

DISTRIBUTION

National Aeronautics and
Space Administration
Ames Research Center
Moffett Field, California 94035

NASA

SOFIA

Reply to Attn of: 213-4

Wednesday, September 12, 1990

To: SOFIA Distribution

From: Nans Kunz
SOFIA Aircraft Systems Manager

Subject: Cavity Door Design

A second meeting is scheduled to review the progress on the cavity door designs by Paul McKim and Will Vallotton. This will be an informal meeting, not a viewgraph presentation. You are invited to participate by either attending the meeting or sending comments about the attached design guide.

When: 10:00 AM Wednesday September 26
Where: N213-204A

The attached is the third revision of the design guide to be used in deriving a new conceptual design for the cavity door. Thank you for comments on the earlier versions, the majority of which have been incorporated.

Thanks,

Nans

DISTRIBUTION:

EARL DALEY 213-4
JIM EILERS 213-4
PHIL FORD 213-4
JEFF LOGAN 213-4
TERI KAISER 213-4
JULIE POLLITT 213-4
WILL VALLOTTON 213-4
NORM YETKA 213-4
JIM HANRATTY 213-2
DENNIS KOGA 227-2
STEVE KLOTZ T045-2
BOB HOLMES 213-8
PAUL McKIM 213-15
GARY THORLEY T041-3
CHRIS WILTSEE T041-3
SYLVIA COX T041-3
STEVE HING 244-10
JERRY HIRATA T041-3
DAVE KOCH T041-3
DAVE LANGTRY T041-3
DAN MACHAK T041-3
BOB YEE 244-10
TED DUNHAM 245-6
ED ERICKSON 245-6
JACKIE DAVIDSON 245-6
CARL GILLESPIE 211-12
RANDY REYNOLDS 240-2
STEVE SLUKA 240-2
GABE PACE 218-6
LAURA DOTY 218-6
GAV TAYLOR T041-3
ROSE ENGINEERING 227-6

Wednesday, September 12, 1990

Cavity Door Design Goals

The purpose of this document is to describe the top level design goals for the cavity door. This is not a specification but only a guide to be used for deriving potential conceptual designs. The actual loads, insulation properties, factors of safety, etc. will be determined in the development phase in conjunction with the aircraft modifier in the same manner as the rest of the aircraft modifications.

Background

To incorporate the results of the recently completed SOFIA wind tunnel test, a new cavity door design concept needs to be derived. The primary addition that needs to be incorporated is a design that aerodynamically simulates the aft fillet fairings (figure 2). The new design will need to meet or address each of the following:

Operation

Typical mission. Prior to takeoff the door acts as a thermal barrier so that the cavity can be pre-cooled. Besides being insulated the door needs seal sufficiently to minimize air leakage. The door will also be required to resist a slight over pressure so that any air leakage is outward from the cavity. Any mechanisms required for door motion need to be designed to resist icing or freezing (heaters may be considered to deice the door mechanisms during climb out).

After takeoff and during climbout, or any time the door is closed the door becomes the exterior aerodynamic surface of the aircraft and therefore needs to resist the corresponding loads. The magnitude of the aerodynamic loads is sensitive to the exterior shape of the cavity door. Aerodynamic drag is also a consideration and should be minimized.

The majority of the mission will be with the door open and the telescope tracking. In this mode the opening of the cavity door should be large enough to provide an unvignetted field of view for the telescope and cameras including their required motions at a given elevation angle (see attached sketches). In addition the door opening will track the position of the telescope during coarse elevation angle changes.

While open, if the door is part of the shear layer control device it needs to simulate aerodynamically or work in conjunction with the aft ramp with fillet fairings at any elevation position.

For fail safe operation the cavity door will be required to close with the telescope at any location within its dynamic envelope. The addition of a manual backup for the door tracking and closing mechanisms should also be considered.

Maintenance

The telescope requires periodic maintenance that will require the removal of the telescope head ring, the primary mirror, and possibly other large structural pieces. These pieces with their handling fixtures may not fit through the operating opening of the cavity door. Therefore, the cavity door mechanism needs either another mode of operation that creates a larger opening, or it needs to be easily removable.

Structural

The door is required to resist aerodynamic loads from the entire flight envelope, whether open, closed or somewhere between. The door shall be designed using standard aircraft practice and factors of safety, with increased factors of safety as appropriate to account for uncertainties in the loading.

Shear Layer Control

Incorporate Wind Tunnel Test results (figure 1)
- 30° aft ramp
  extending into the cavity about 40 inches
  with a bullnose radius of about 12 inches
- 3-D aft fillet fairings w/side strakes
- 2-D forward fillet fairings

Opening Size (see attached sketches)

The full opening in the aircraft is sized for unvignetted telescope motions of:
20° to 60° in elevation angle (figure 3)and
+ or - 4° crosselevation (figure 4)

The operating opening of the cavity door needs to be sized for unvignetted telescope motions of:
+ or - 2° elevation (figure 5) and
+ or - 4° crosselevation (figure 4)
plus 11 inches elevation for cameras (8" diameter with 6° FOV), yielding an approximate rectangular opening 135" x 125" with 48" R corners (figure 6)

Tracking Range (unvignetted)

For telescope elevation angles of 22° to 58° above horizontal.
Tracking rate 2° per second

Telescope Dynamic Envelope (figure 7)

5° half angle cone in the LOS and cross elevation
For telescope elevation angles of 15° to 70°

Thermal/Cavity Environment

Cavity pre-cool temperature is -40°F
Cavity pressure + or - 1.0 psi compared to ambient
Minimum airleakage is desired
Weather tight seal, from rain etc., provide for water runoff

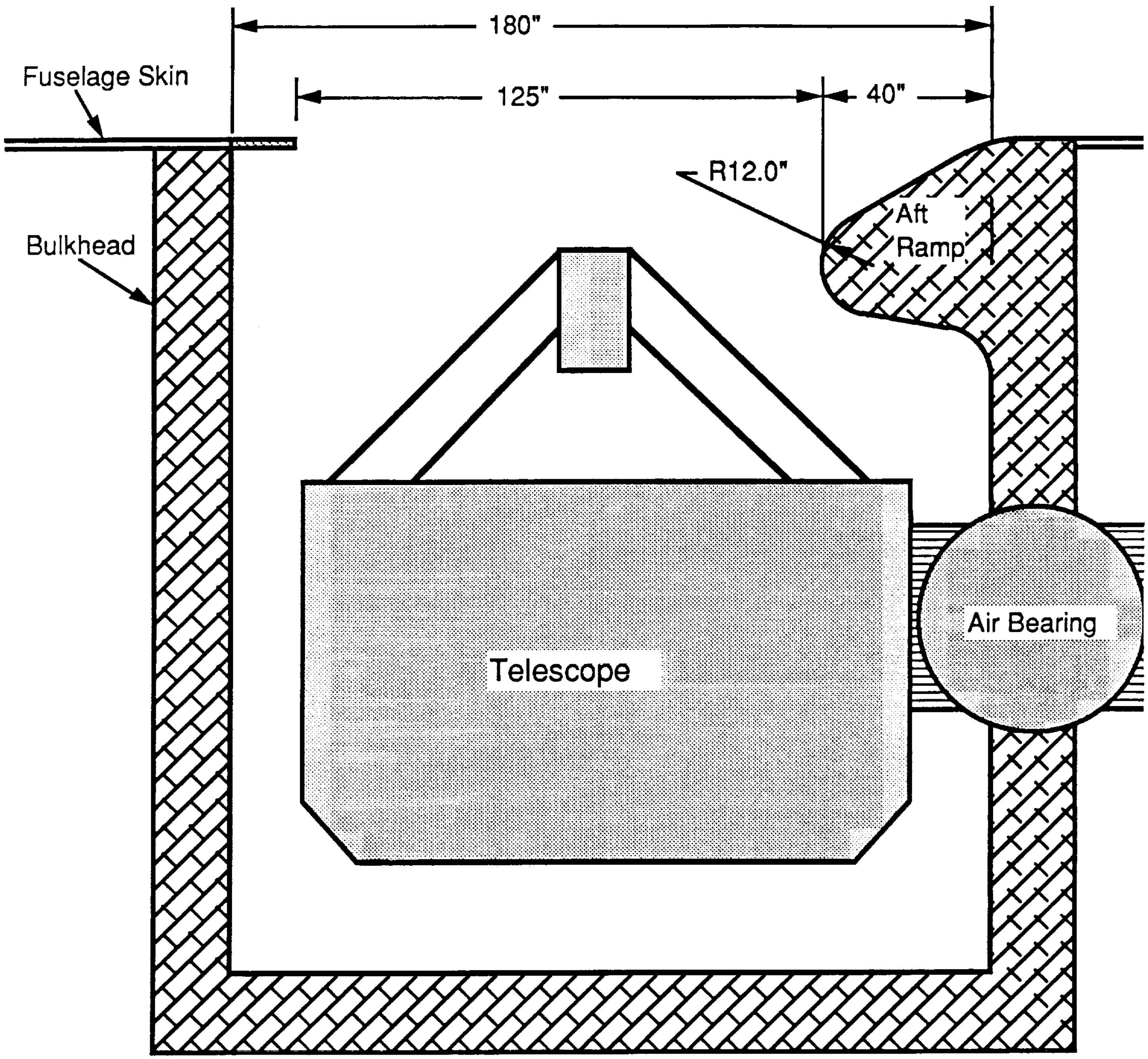
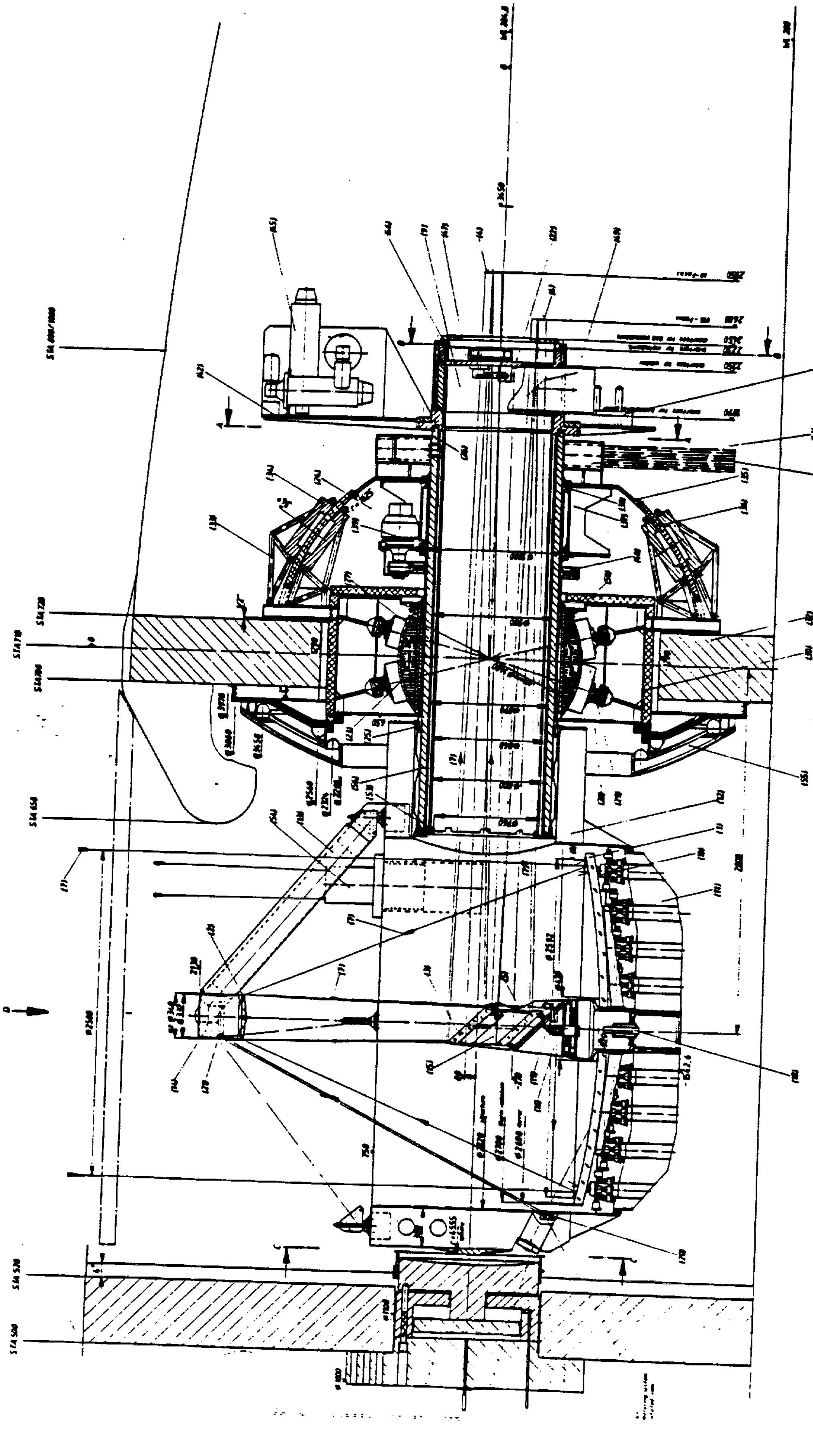

180"
Fuselage Skin
125"
40"
R12.0"
Aft
Ramp
Bulkhead
Air Bearing
Telescope

Figure 1



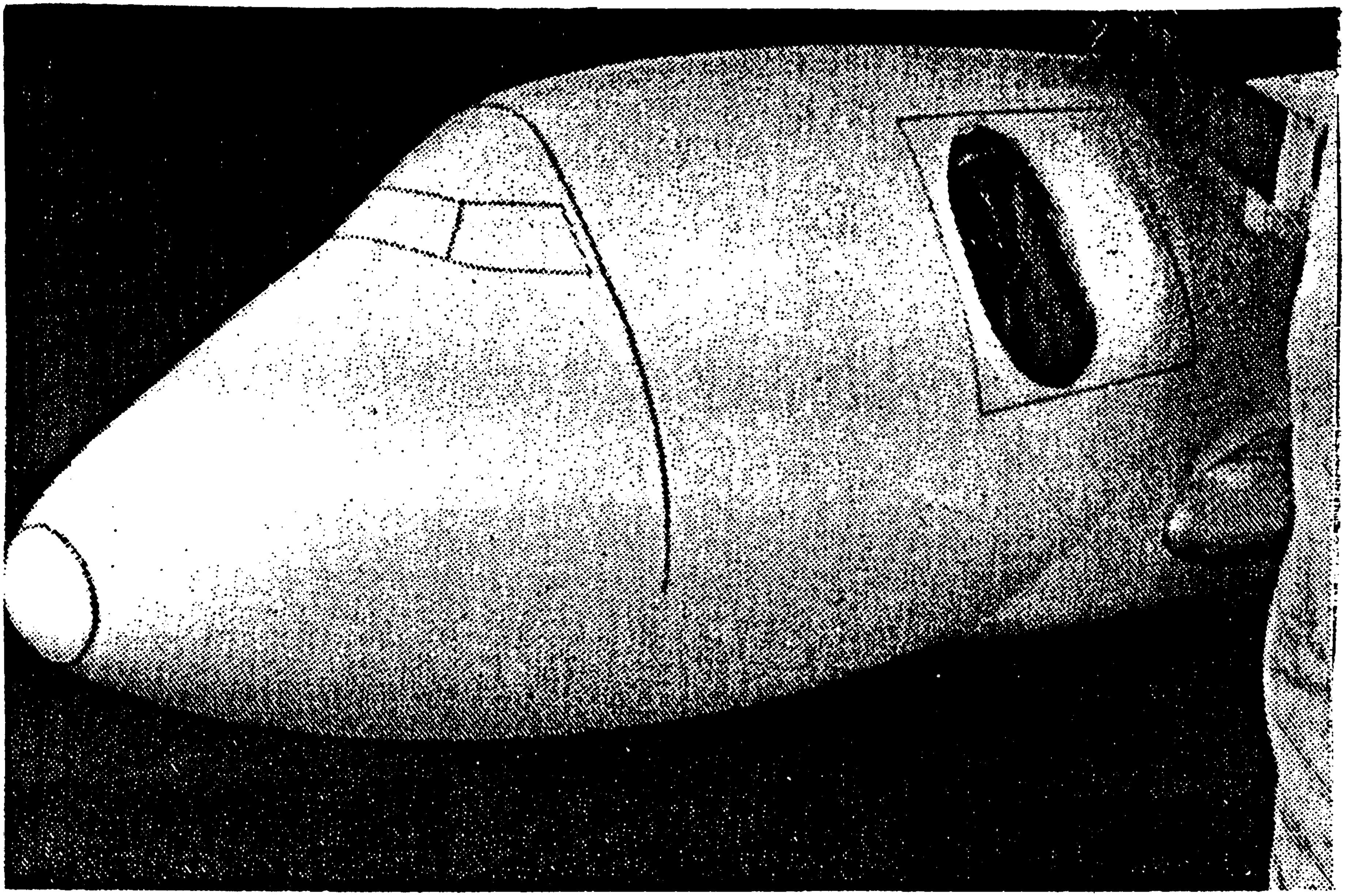


FIGURE 2

FULL APERTURE REQUIREMENT
ELEVATION (Roll) DIRECTION

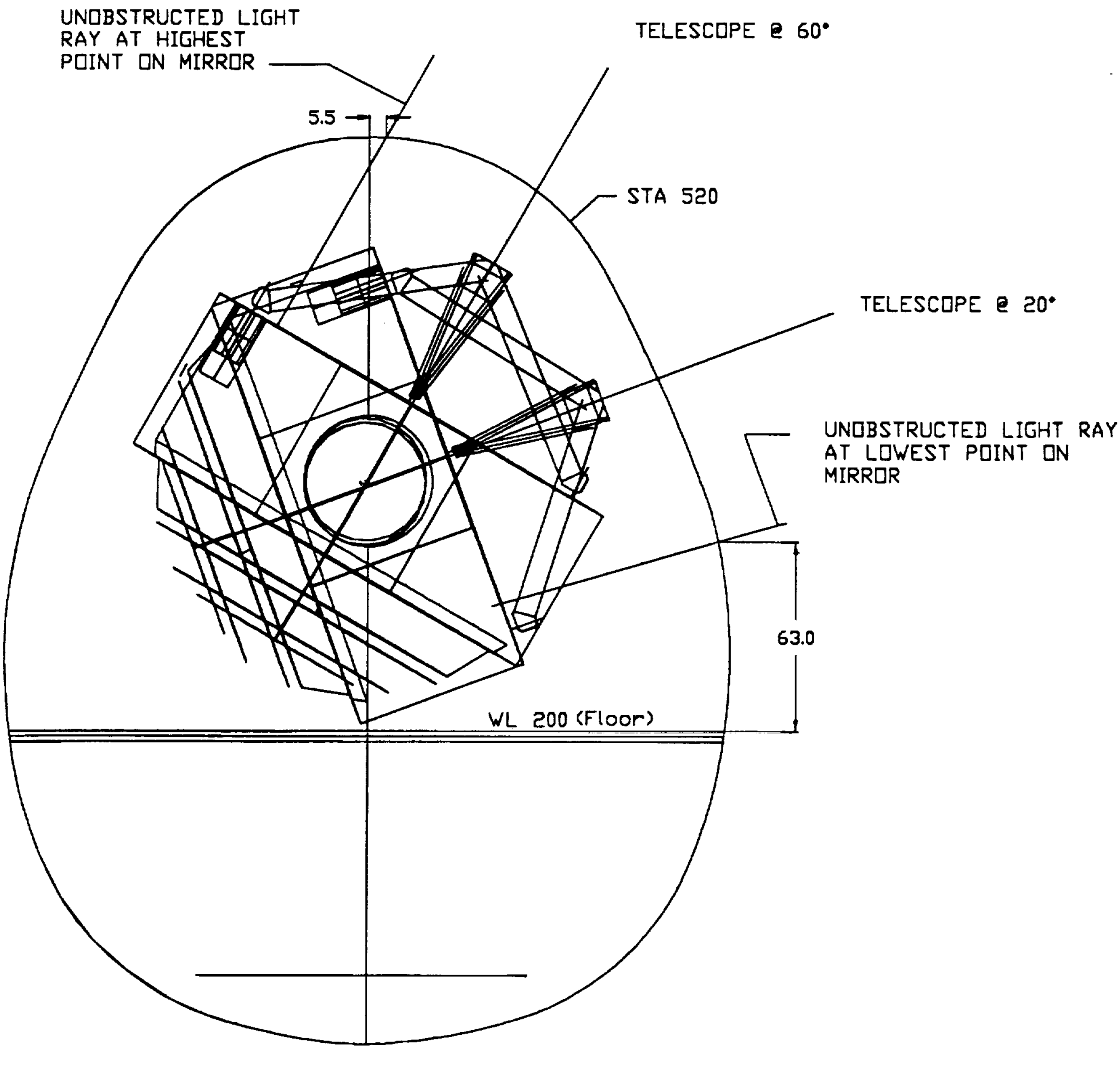
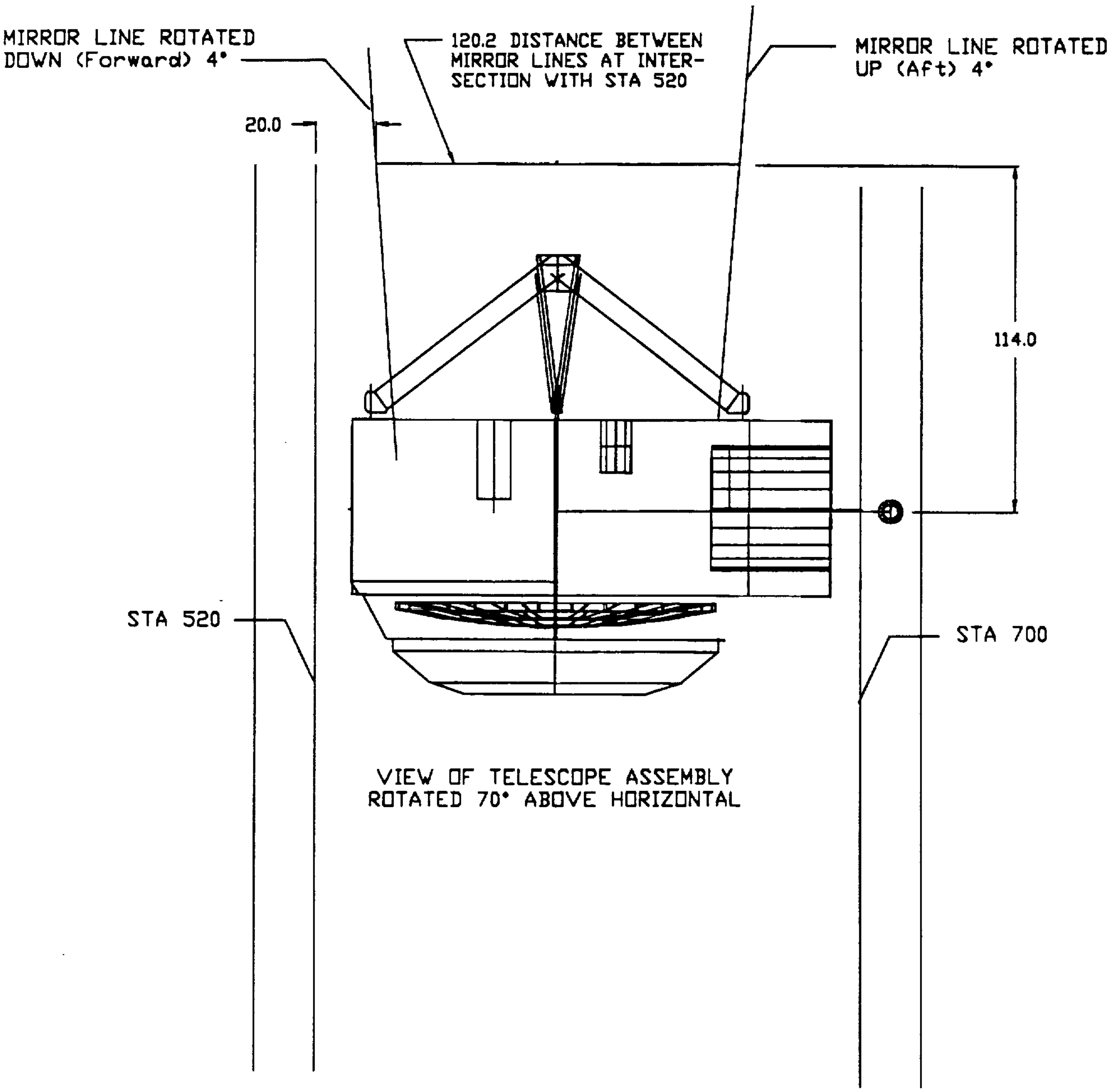


FIGURE 3

FULL AND INSTANTANEOUS APERTURE REQUIREMENT
CROSS-ELEVATION (Fore-Aft) DIRECTION



VIEW OF TELESCOPE ASSEMBLY
ROTATED 70° ABOVE HORIZONTAL

FIGURE 4

INSTANTANEOUS APERTURE REQUIREMENT
ELEVATION (Roll) DIRECTION

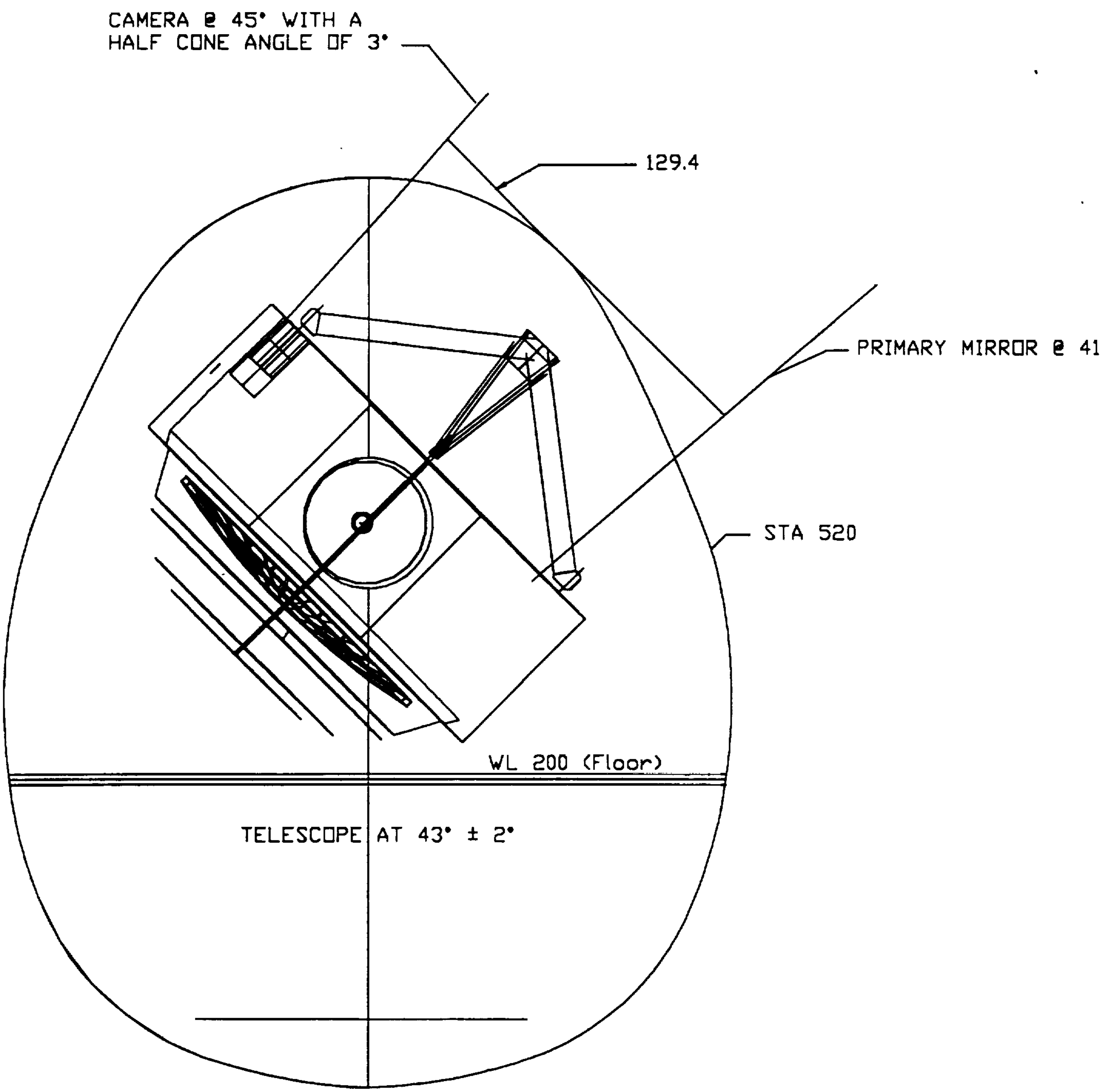


FIGURE 5

INSTANTANEOUS APERTURE REQUIREMENT

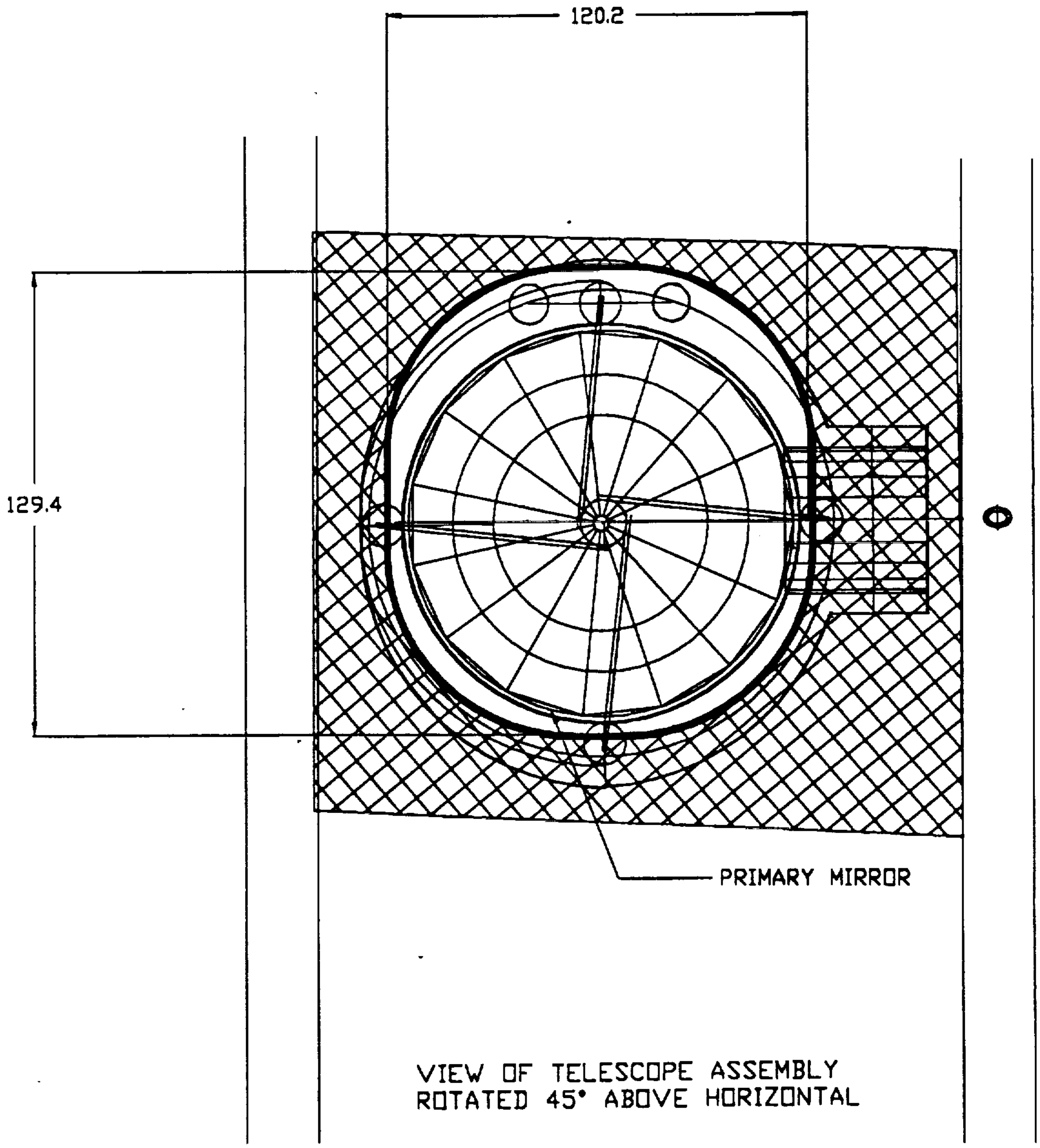


FIGURE 6

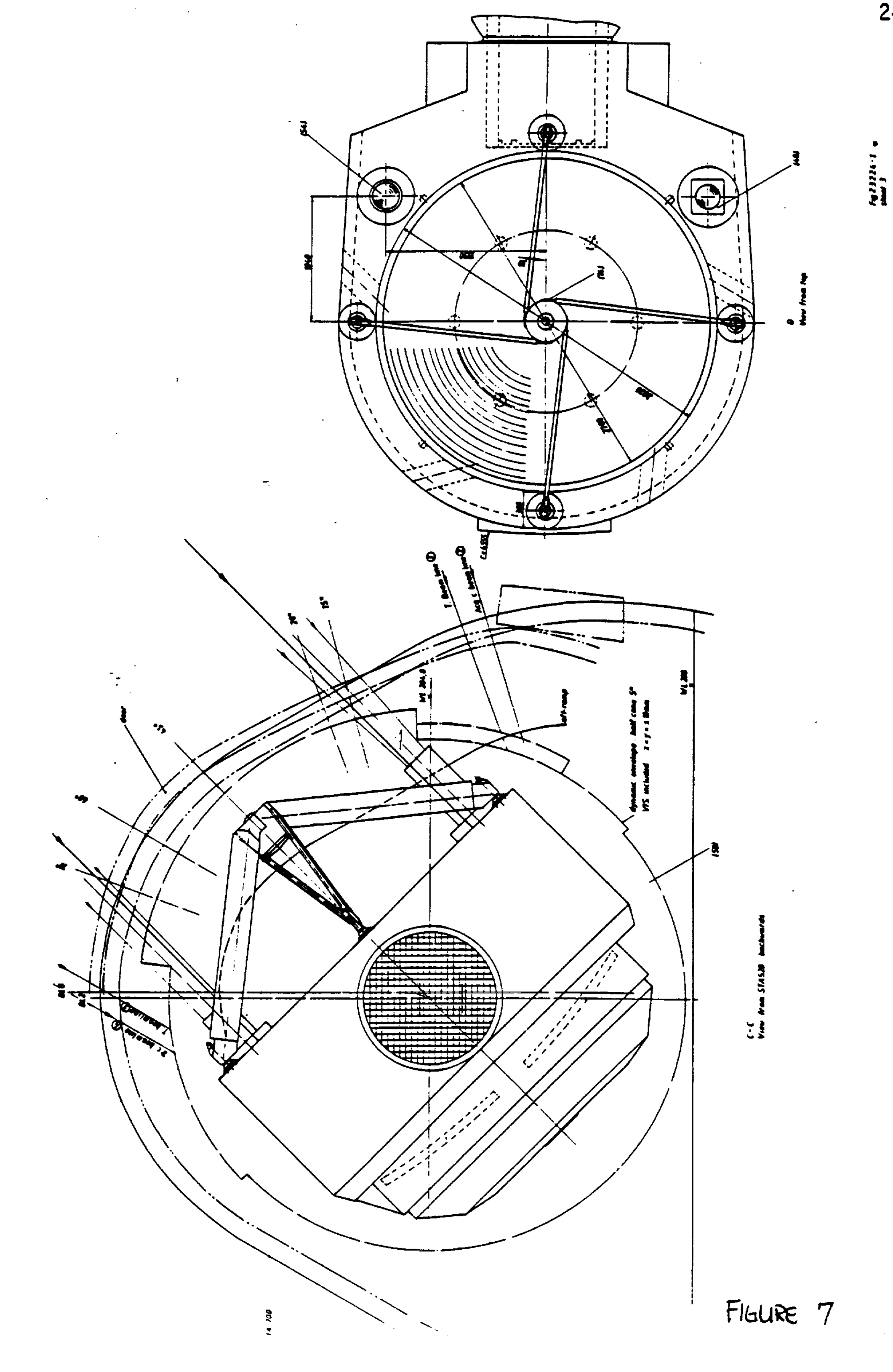


FIGURE 7